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(71) Applicant: **GM Global Technology Operations, Inc.**
Detroit, MI 48265-3000 (US)

(72) Inventors:
• **Brandt, Peter**
63739 Aschaffenburg (DE)

• **Charle, Heiko**
65428 Rüsselsheim (DE)
• **Sahlbom, Daniel**
46492 Mellerud (SE)

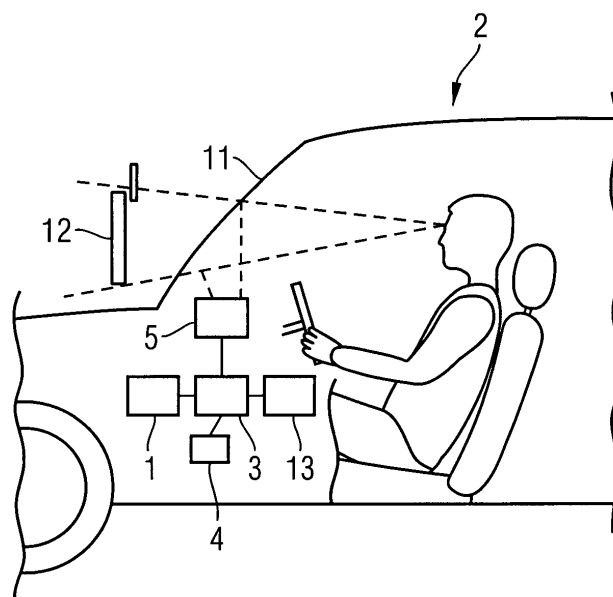
(74) Representative: **Hassa, Oliver Michael**
Reinhard-Skühra-Weise & Partner
Patentanwälte
Friedrichstrasse 31
80801 München (DE)

(54) **Holographic information display**

(57) The present invention relates to a holographic information display for a motor vehicle comprising: a receiver for receiving at least one information content, an image processing unit determining a hologram of a display indicating the at least one information content, a

holographic projector having a spatial light phase modulator generating the determined hologram and a coherent light source emitting towards the spatial light phase modulator for projecting a reconstructed hologram of the display to present the at least one information content.

Fig. 1



Description

[0001] The present invention relates to a holographic information display, in particular to a holographic information display for a motor vehicle.

[0002] Head-up displays are used in motor vehicles to display information into the sight field of a driver. One kind of head-up displays uses a holographic foil attached to the windscreen. The head-up display projector projects the information content onto the foil. A driver can read or see the information by focussing onto the foil. Another kind of head-up displays uses the windscreen as a semi-transparent mirror for projecting a virtual image into the sight field of a driver. The driver perceives the image at a certain distance to the windscreen outside of the car. The virtual distance of the object to the windscreen constant and determined by the optic elements of the head-up display projector.

[0003] The head-up display projector comprises a light source, e.g. LEDs, for illuminating a liquid crystal projector and a plurality of optical elements. Static diffractive optic elements can be used instead of normal lenses and mirrors. Adapted optical elements are installed in the head-up display for adapting the projector to different wind screen models.

[0004] There is the object of a different approach for providing information to a driver of a motor vehicle.

[0005] According to a first aspect of the invention a holographic information display for a motor vehicle comprises a receiver for receiving at least one information content, an image processing unit determining a hologram of a display indicating the at least one information content, a holographic projector having a spatial light phase modulator generating the determined hologram and a coherent light source emitting towards the spatial light phase modulator for projecting a reconstructed hologram of the display to display the at least one information content.

[0006] The spatial light phase modulator allows to generate any hologram and in particular allows to dynamically change the hologram. The holographic projector emits a light beam having a wave front determined by the hologram. As the hologram can be generated in any shape, any wave front design can be implemented. The optics of such a holographic projector is therefore not limited to geometric optics having just one focus point. A plurality of focus points and focus points shifting with time can be implemented with the holographic projector. This allows the projection of objects giving a spectator the impression of a three dimensional object and of objects at different virtual distances to the spectator.

[0007] According to an embodiment the vehicle display is connected to a vehicle device for receiving the information content from the vehicle device.

[0008] The vehicle device may be at least one of a radio, an entertainment system, an infotainment system, a cellular phone system, an air-conditioner system, a park assistant system, a navigation system, and a board

computer.

[0009] According to an embodiment the image processing unit is an image processing unit for determining a hologram of a display having a plurality of layers separated by a distance from each other, and comprising a decision unit for determining the priority of the at least one information content and an assignment unit for assigning an information content to be displayed to one of the plurality of layers based on the priority determined.

[0010] An information content of a high priority can be displayed in a short virtual distance to a driver to gain the attention of the driver. A layer of the plurality of layers may be translucent, wherein the layer of the plurality of layers is in front of another layer of the plurality of layers. Layers behind this layer can shine through the layer and remain observable for the driver.

[0011] According to an embodiment a coherent light source is a coherent light source for emitting a first beam and a second beam having different wave lengths, and the image processing unit is an image processing unit for determining a first hologram of a first part of the display to be displayed in a first colour and a second hologram of a second part of the display to be displayed in a second colour different to the first colour and for superimposing the first hologram and the second hologram to the determined hologram. Multicoloured displays can hence be generated by the same holographic projector using a single spatial light phase modulator.

[0012] An other approach for displaying multi-coloured holograms is to use a plurality of coherent light sources emitting at different wavelength. The light sources are switched on alternately. The spatial phase light modulator generates synchronic to the switching of the light sources different holograms. The holograms represent the differently coloured parts of the multi-coloured hologram. The switching is performed with a frequency above 50 Hz or above a switching-frequency in-perceivable for the human eye.

[0013] According to a second aspect a measuring device for a motor vehicle comprises a measuring unit measuring at least one value regarding the status of a motor vehicle, an image processing unit determining a hologram of a display indicating the at least one value measured, a holographic projector having a spatial light phase modulator generating the determined hologram and a coherent light source emitting towards the spatial light phase modulator for projecting a reconstructed hologram of the display.

[0014] The measuring unit can be at least one of a velocity gauge, a tachometer, a tank gauge, a gauge for measuring the distance to an obstacle, a temperature sensor for a coolant liquid of the motor, and a temperature sensor for the temperature in a cabin of the motor vehicle, but is not limited thereto.

[0015] The display indicating the at least one value measured can be according to one embodiment a speedometer display, a tachometer display, a tank gauge display, a park assistance display, a cruise control display,

a motor status display, and a air-conditioner system display.

[0016] According to one embodiment the measuring device has a receiver for receiving at least one of a predetermined value and a predetermined value range and the display comprises a first layer indicating the at least one value measured and the second layer indicating the at least one of the received predetermined value and the received predetermined value range, wherein the first layer and the second layer being separated by a distance. The second layer may be translucent.

[0017] According to an embodiment the measuring device has a data processing unit for determining a scaling of the display based on the at least one value measured.

[0018] The present invention will be described in greater detail along with embodiments and figures. In the figures:

Fig. 1 illustrates an embodiment of a holographic information display;

Fig. 2 illustrates a holographic projector used in the embodiment of figure 1;

Fig. 3 shows a display generated by the embodiment of figure 1;

Fig. 4 shows an imaginary side view on the display of figure 3;

Fig. 5 shows another display displayed by the embodiment of figure 1;

Fig. 6 shows an imaginary side view of figure 5;

Fig. 7 shows an other display displayed by the embodiment of figure 1; and

Fig. 8 shows another display displayed by the embodiment.

[0019] A first embodiment used for a speedometer display is illustrated along with figure 1. A velocity gauge 1 is provided in a motor vehicle 2 for measuring the speed of the motor vehicle. The velocity gauge 1 generates a signal indicating the speed and transfers the signal to an image processing unit 3.

[0020] The image processing unit 3 generates hologram of a display of a speedometer. The image processing unit 3 loads an image of a dial of the speedometer from a storage device 4. In the storage device different dials can be stored so the driver or a manufacturer of a vehicle can chose from. A design of a speedometer needle is stored in the storage device 4. The image processing unit orientates the displayed needle according to the signal obtained from the velocity gauge such that the speed of the motor vehicle is indicated by the speedometer display. The image processing unit 3 combines the

needle and the dial to a single object. Based on the single object the image processing unit calculates a pattern for a hologram.

[0021] A generated hologram is transferred to a holographic projector 5.

[0022] The holographic projector 5 comprises a receiver 6, a control unit 7, a coherent light source 8, a spatial light phase modulator 9, and a window 10. The coherent light source 8 emits light with a well defined wave front. The light with its wave front is reflected by the spatial light phase modulator 9 towards the window 10. The spatial light phase modulator is divided into a plurality of individually controlled light phase modulators. Each of these light phase modulators retards the light phase of the fraction of light falling onto the surface of the respective light phase modulator. Thus, the wave front of the light reflected by the spatial light phase modulator 9 can be transformed to any desired shape.

[0023] The receiver 6 receives the hologram of the image processing unit 3. The control unit 7 divides the hologram into sections corresponding to the light phase modulators of the spatial light phase modulator 9. For each of these sections a control signal is generated and supplied to the spatial light phase modulator 9. Thus, the hologram received by the receiver 6 is transferred to the spatial light phase modulator 9.

[0024] The holographic projector 5 reconstructs the hologram and projects the reconstructed hologram into the sight field of a driver or any other spectator within the vehicle. As illustrated in Fig. 1 the windscreen 11 of the motor vehicle can be used as translucent and reflective medium to bring the projected hologram into the sight field of the driver.

[0025] The driver sees the projected hologram which corresponds to the speedometer display assembled by the image processing unit 3.

[0026] A data processing unit 13 is provided which determines velocity ranges or specific velocities of particular interest. Such a velocity of particular interest can be a speed limit, for instance. A data processing unit can be therefore connected to a navigation system or a traffic sign recognition system. A velocity range can be given based on a chosen gear.

[0027] Fig. 3 shows a dial of a speedometer display in a front view. An imaginary side view of the speedometer display is given in Fig. 4 to illustrate the three dimensional impression of the speedometer. The speedometer display comprises a dial 20, a needle 21, a scale indicating several speeds. These three elements are preferably arranged in the same layer. In a second layer in front of the first layer the particular velocity and/or a particular velocity range 23 are arranged. The different virtual distance of the display elements to the driver make them distinguishable.

[0028] A velocity range can be indicated by a semi-transparent layer 24 which is arranged in front of the dial 20 (see Fig. 5, 6).

[0029] Fig. 7 illustrates a speedometer display having

an area 25 displayed in a colour different to the dial 20. This coloured area can be used for warning purposes. The different colour can be implemented by different shadings, intensity etc. Another embodiment uses two light sources emitting at different wave lengths to provide this differently coloured area 25. Both light sources may be directed to the same spatial light phase modulator 9. The hologram generated by the spatial light phase modulator 9 is a superposition of two holograms, one representing the dial 20 and a second hologram representing the differently coloured area 25.

[0030] According to a further embodiment a scaling of the dial is changed based on the actual velocity. Several velocity ranges and corresponding dial scalings are stored in a memory device. A comparator compares the actual velocity to the velocity ranges and chooses the respective dial scaling.

[0031] The dial can be segmented in areas of different scalings. This can be visualized by displaying the different areas in different virtual distances to the driver.

[0032] Instead of a dial a digital display, a bar display, etc. can be used for a speedometer display.

[0033] The above displays can be combined in any way.

[0034] The particular velocity range of interest can be the adjustable range of an adapted cruise control.

[0035] The speedometer display is an illustrative embodiment for other measuring devices, like a tachometer or of a temperature sensor in the vehicle cabin, in the motor area. The angular velocity, the temperature are measured by respective devices. The signal is transferred to the image processing device.

[0036] The holographic projector can be coupled to a navigation system to display a virtual map into the sight view of a driver. The virtual map can be displayed as a two dimensional or as a three dimensional object. The navigation system generates an information content indicating at each crossing the direction to the destination. According to the temporal order the vehicle will pass the crossings the respective signs, like turn left, turn right, go straight, etc. are displayed in an increasing virtual distance to the driver.

[0037] Infotainment systems can provide an information content indicating a radio station selected, supplemental radio information, music notes, news ticker etc. This information can be displayed in different virtual distances according to their priority. The priority can be chosen by the driver himself.

[0038] The holographic projector can be connected to a cellular phone system. The address book is displayed. Each time an item of the address book, i.e. an address, is selected, the respective address is highlighted. The highlighting can be performed by displaying the selected address in a first layer wherein the address book is displayed in a second layer. The second layer is in a larger virtual distance to the spectator than the first layer.

[0039] After selecting an address and starting a communication, the address book or display elements of the

phone system can be moved to large virtual distance. After a communication is established the display of the phone system is moved forward to a closer virtual distance.

[0040] The virtual distance of the display can be adapted to the speed of the vehicle. A velocity gauge measures the speed of the vehicle. The holograms are determined to have a larger virtual distance to the driver or any other spectator with increasing speed. This can be beneficial for a driver observing more distanced points of the road as he moves with higher speed. A refocusing of his eye to perceive the information content displayed by the holographic information system at the determined virtual distance can be minimized.

Claims

1. A holographic information display for a motor vehicle comprising:

a receiver (6) for receiving at least one information content,
an image processing unit determining a hologram of a display indicating the at least one information content,
a holographic projector (5) having a spatial light phase modulator (9) generating the determined hologram and a coherent light source (8) emitting towards the spatial light phase modulator (9) for projecting a reconstructed hologram of the display to present the at least one information content.

2. The holographic information display according to claim 1, wherein the holographic information display being connected to vehicle device for receiving information content from the vehicle device.

3. The holographic information display according to claim 1, the vehicle device being at least one of a radio, an entertainment system, an infotainment system, a cellular phone system, an air conditioner system, a park assistant system, a navigation system, and a board computer.

4. The holographic information display according to claims 1 or 2, wherein the vehicle device comprising a measuring unit measuring at least one value regarding the status of a motor vehicle, and the image processing unit comprising an image processing unit determining a hologram of a display indicating the at least one value measured.

5. The holographic information display according to claim 4, wherein the measuring unit is of at least one of a velocity gauge, a tachometer, a tank gauge, a gauge for measuring the distance to an obstacle, a

temperature sensor for a coolant liquid of the motor, and a temperature sensor for the temperature in a cabin of the motor vehicle.

6. The holographic information display according to claims 4 or 5, wherein the display is at least one of a speedometer display, a tachometer display, a tank gauge display, a park assistance display, a cruise control display, a motor status display, and an air conditioner system display.
7. The holographic information display according to one of the claims 1 to 6, wherein the image processing unit is an image processing unit for determining a hologram of display having a plurality of layers, separated in view line by a distance from each other, and comprises a decision unit for determining the priority of the at least one information content and an assignment unit for assigning an information content to be displayed to one of the plurality of layers based on the priority determined.
8. The holographic information display to claim 7, wherein a layer of the plurality of layers is translucent, the layer of the plurality of layers is in front of an other layer of the plurality of layers.
9. The holographic information display according to one of the claims 1 to 8, wherein the coherent light source (8) is a coherent light source (8) for emitting a first beam and a second beam having a different wavelengths, and the image processing unit is an image processing unit for determining a first hologram of a first part of the display to be displayed in a first colour and a second hologram of a second part of the display to be displayed in a second colour different to the first colour, and superimposing the first hologram and the second hologram to the determined hologram.
10. The holographic information display according to one of the claims 1 to 8, wherein the coherent light source (8) is a coherent light source (8) for alternately emitting a first beam and a second beam having different wavelengths, the image processing unit is an image processing unit for determining a first hologram of a first part of the display to be displayed in a first colour and a second hologram of a second part of the display to be displayed in a second colour different to the first colour, and a synchronisation unit is provided for alternately generating the first and the second hologram by the spatial light phase modulator (9) synchronously to the coherent light source (8).
11. The holographic information display according to

claims 1 to 10, comprising a velocity gauge measuring the velocity of the motor vehicle, a data processing unit determining a virtual distance for the display based on the velocity of the vehicle, and wherein

the image processing unit is adapted for determining the hologram of a display indicating the at least one information content in the determined distance.

12. The holographic information display according to 11, having a receiver (6) for receiving at least one of a predetermined value and a predetermined value range and wherein the display comprises a first layer indicating the at least one value measured and a second layer indicating the at least one of the received predetermined value and the received predetermined value range, the first layer and the second layer being separated by a distance.
13. The holographic information display according to one of the claims 4 to 12, having a data processing unit for determining a scaling of the display based on the at least one value measured.
14. A method for displaying a status of a motor vehicle comprising the steps of:
measuring at least one value regarding the status of a motor vehicle,
determining a hologram of a display indicating the at least one value measured,
generating the determined hologram by use of a spatial light phase modulator (9)
illuminating the spatial light phase modulator (9) using a coherent light source (8) for projecting a reconstructed hologram of the display indicating the value measured.
15. The method according to claim 14, wherein a hologram of a display having a first layer and a second layer is determined, the first layer being separated from the second layer by a distance, the first layer indicating the value measured and the second layer indicating at least one of a predetermined value and a predetermined value range.
16. The method according to claim 14 or 15, wherein an information content of high priority is received and the hologram of a display having a first layer and a third layer is determined the third layer being in front of and separated by a distance of the third layer, the first layer indicating the value measured and the third layer displaying the information content of high priority.

Fig. 1

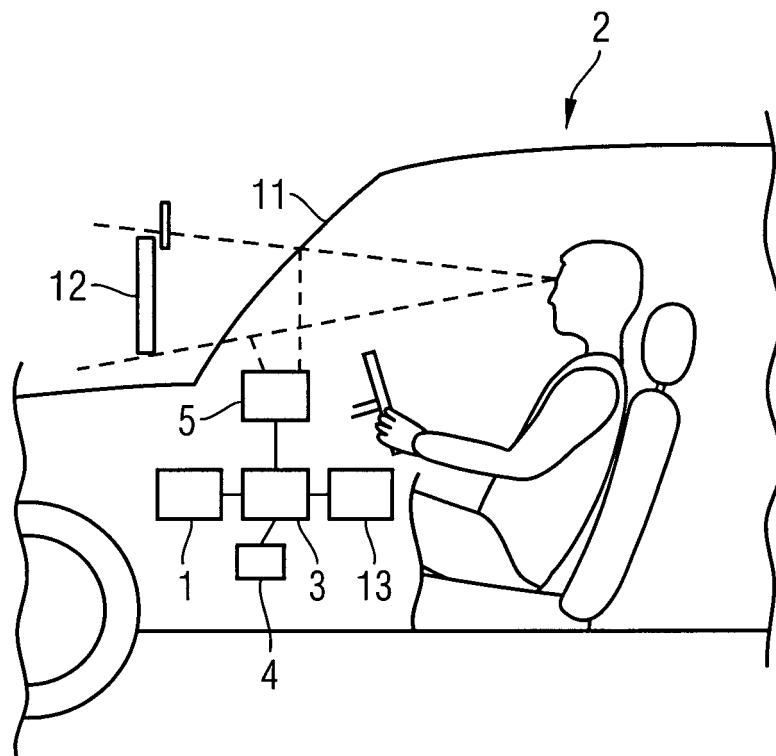


Fig. 2

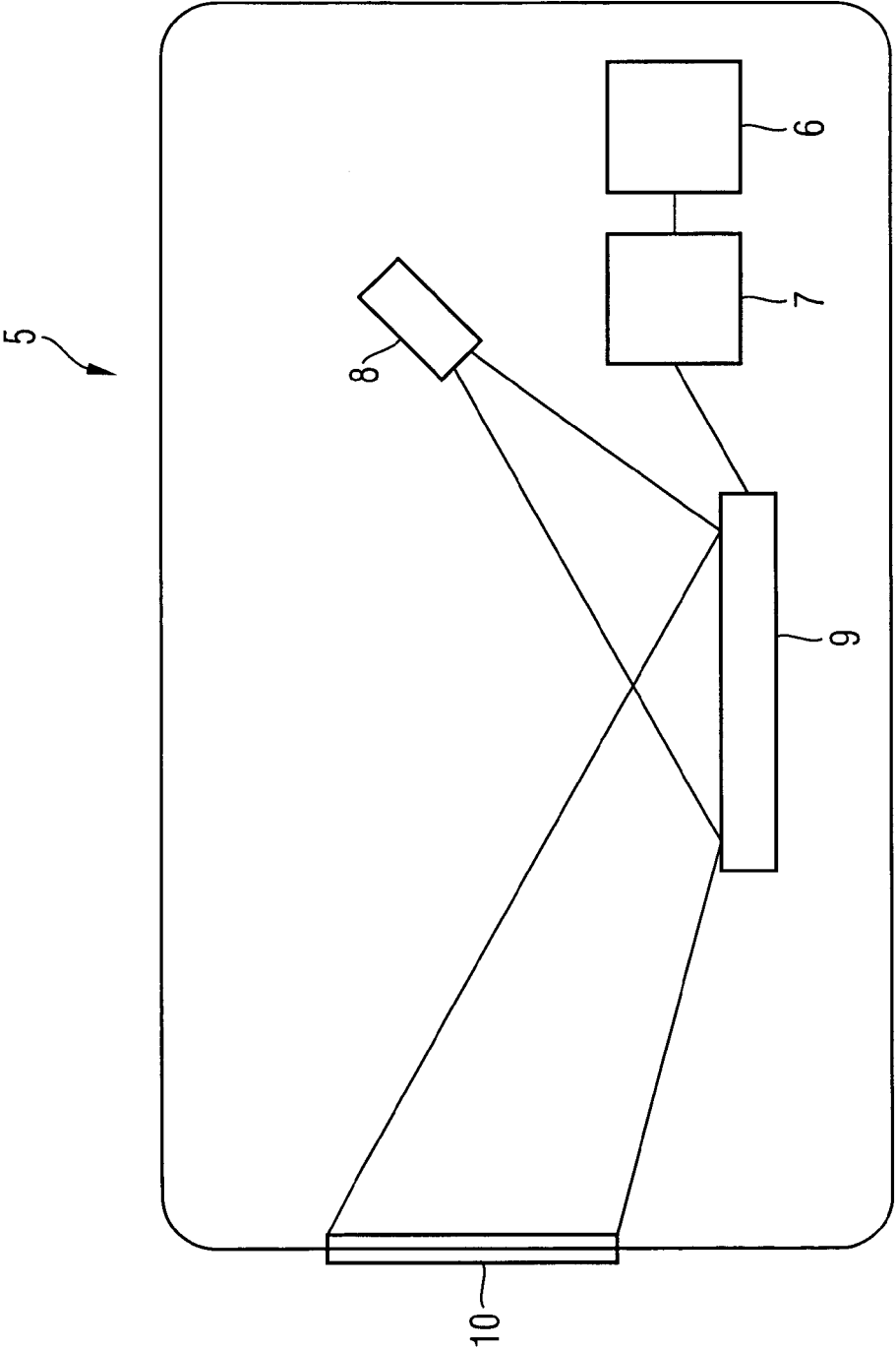


Fig. 3

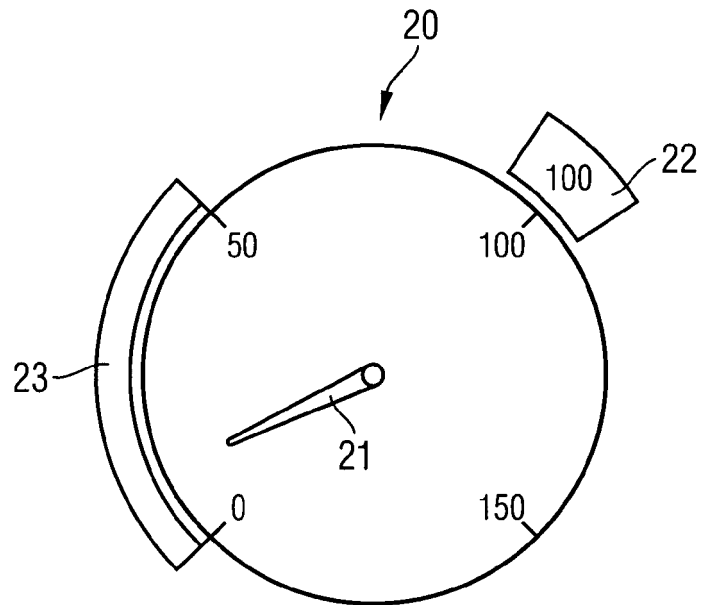


Fig. 4

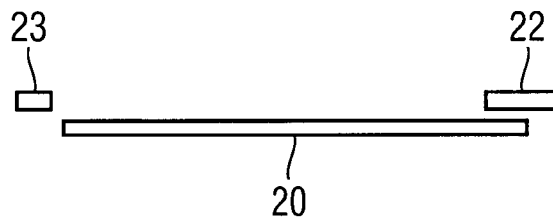


Fig. 5

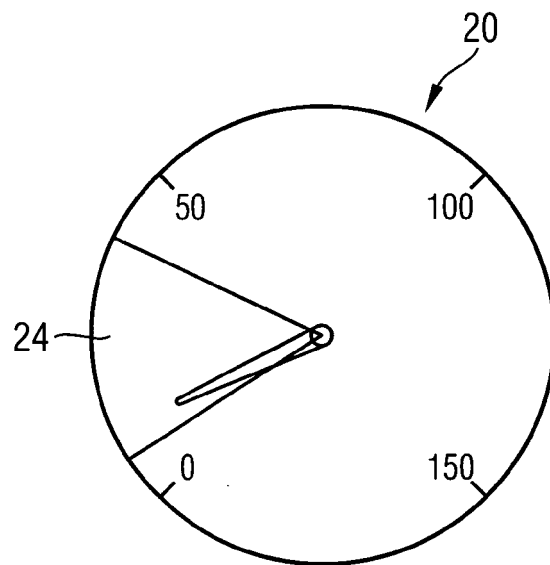


Fig. 6

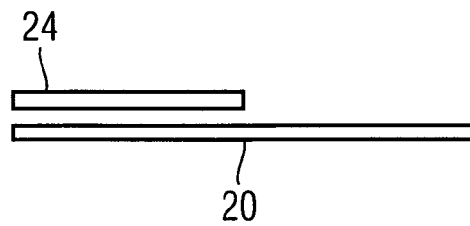


Fig. 7

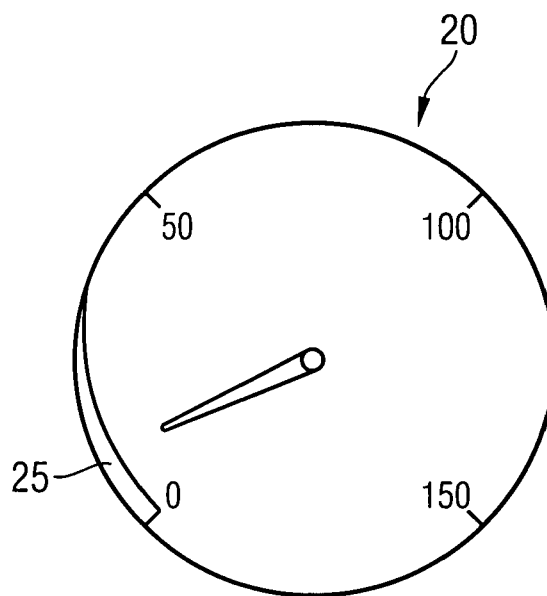
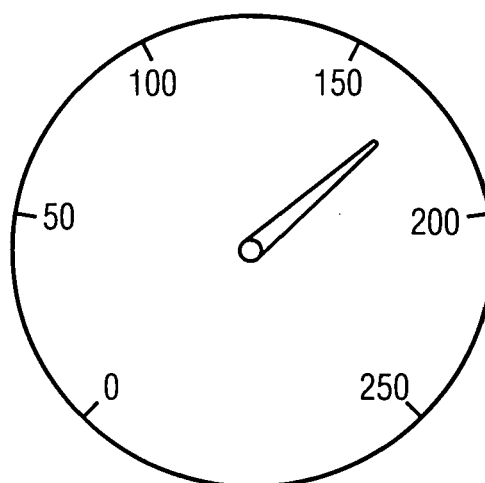


Fig. 8





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 00 6522

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2006/134404 A (LIGHT BLUE OPTICS LTD [GB]; CABLE ADRIAN [GB]; BUCKLEY EDWARD [GB]) 21 December 2006 (2006-12-21)	1-5,14	INV. G02B27/01 G03H1/22
Y	* page 11, last paragraph - page 13, last paragraph *	6-8, 11-13, 15,16	
	* page 19, paragraph 1 *		
	* figure 2 *		

Y	DE 44 45 555 A1 (HYUNDAI ELECTRONICS IND [KR] HYUNDAI AUTONET CO [KR]) 29 June 1995 (1995-06-29)	6	
	* column 5, line 44 - column 6, line 8 *		
	* figures 3-5 *		

A	US 6 819 469 B1 (KOBAYASHI IGOR M [US]) 16 November 2004 (2004-11-16)	1-6,14	
	* column 9, line 8 - line 42 *		
	* column 11, line 29 - column 12, line 8 *		
	* figure 3 *		

Y	DE 37 35 983 A1 (YAZAKI CORP [JP]) 3 May 1989 (1989-05-03)	7,8, 11-13, 15,16	TECHNICAL FIELDS SEARCHED (IPC) G02B G03H
	* column 5, line 51 - column 6, line 18 *		
	* claim 8 *		
	* figure 7 *		

X	WO 2007/031797 A (LIGHT BLUE OPTICS LTD [GB]; CABLE ADRIAN [GB]) 22 March 2007 (2007-03-22)	1,9,10	
	* page 7, line 4 - line 6 *		
	* page 22, paragraph 1 *		
	* figure 2 *		

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 22 January 2008	Examiner von Hentig, Roger
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

3
EPO FORM 1503 03.82 (P04C01)



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 00 6522

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 467 263 A (JAPAN SCIENCE & TECH AGENCY [JP]) 13 October 2004 (2004-10-13) * paragraph [0007] - paragraph [0015] * * paragraph [0030] - paragraph [0035] * * figures 1-3 *	1,9,10	
X	----- US 2003/122828 A1 (LUKYANITSA ANDREW A [RU]) 3 July 2003 (2003-07-03) * paragraph [0033] - paragraph [0035] * * paragraph [0049] * * figure 2 *	1,9,10	
A	----- US 6 195 184 B1 (CHAO TIEN-HSIN [US] ET AL) 27 February 2001 (2001-02-27) * figure 1 * * column 5, line 16 - line 52 * -----	1,9,10	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
Place of search		Date of completion of the search	Examiner
Munich		22 January 2008	von Hentig, Roger
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:
- ☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-6,14

relate to a holographic display system which is one of a speedometer display, a tachometer display, a tank gauge display, a park assistant display, a cruise control display, a motor status display or an air conditioner system.

2. claims: 7,8,11-13,15,16

relate to a holographic display system which comprises an image processing unit which is specifically adapted to generate a holographic image which has a plurality of layers being separated by a distance from each other.

3. claims: 9,10

relate to a holographic display system which comprises light sources of different wavelengths.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 00 6522

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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22-01-2008

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 2006134404	A	21-12-2006	NONE	
DE 4445555	A1	29-06-1995	CN 1126321 A	10-07-1996
			JP 7215093 A	15-08-1995
			US 5615023 A	25-03-1997
US 6819469	B1	16-11-2004	NONE	
DE 3735983	A1	03-05-1989	NONE	
WO 2007031797	A	22-03-2007	NONE	
EP 1467263	A	13-10-2004	CA 2473549 A1	24-07-2003
			WO 03060612 A1	24-07-2003
			US 2005041271 A1	24-02-2005
US 2003122828	A1	03-07-2003	NONE	
US 6195184	B1	27-02-2001	NONE	